

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

R E P O R T

OF

GEOLOGICAL OBSERVATIONS

IN THE

SAGUENAY REGION.

BY

ABBÉ J. C. K. LAFLAMME, A.M., D.D.,

PROFESSOR OF MINERALOGY AND GEOLOGY, LAVAL UNIVERSITY.



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SECRET

TO A. R. C. SELWYN, LL.D., F.R.S., F.G.S., &c.

Director Geological and Natural History Survey of Canada.

SIR,—In your instructions respecting the geological researches to be made in the region of the Saguenay, you wished me to pay particular attention to the limestones of the Cambro-Silurian, to the bands of crystalline limestone of the Laurentian, to the deposits of titanite iron ore, and in general to all important geological facts which I might be able to observe. I believe that I am in a position to submit to you some new observations on various points, which will to some extent modify the geological map of the Saguenay region as published by Sir William Logan in 1863.

These observations are, perhaps, not as precise nor as detailed as they might have been had I had more time at my disposal. Moreover, the difficulties which attend such researches in thick forests where the measures are not only covered with dead and live vegetation but also in the majority of instances hidden beneath considerable masses of glacial *detritus*, must necessarily take away from the clearness and precision of a work of observation.

I have the honour to be,

Sir,

Your obedient servant,

ABBÉ J. C. K. LAFLAMME.

QUEBEC, December, 1883.

REPORT

OF

GEOLOGICAL OBSERVATIONS

IN

THE SAGUENAY REGION.

PHYSIOGRAPHICAL SKETCH.

The region which I have more particularly studied is that situated to the north-east of the Saguenay, from Chicoutimi to Lake St. John. Then I examined in detail the level country lying east of the lake, bounded on the north by the small outlet (*petite Décharge*), and on the south by the granitic hills which lie near the centre of Labarre Township, then by the elevated land which runs uninterruptedly and in a straight line from the west end of Lake Kénogami to Lake St. John where the Metabetchouan River empties into the lake.

The portion situated to the north-east of the Saguenay is, to a great extent, limited in that direction, and to the south-west, by two small slightly elevated chains of Laurentian hills, distant at various points from four to five leagues. This kind of basin-like area widens out, however, going up the *Décharge* until it merges in the vast swamps which reach Lake Tshistagama and river Péribonka. This flat country is everywhere covered with a thick layer of quaternary deposits. Taken as a whole, it is eminently suited for agricultural purposes. Besides, as numerous rivers traverse it and flow into the Saguenay, it is one of those districts where lumbering is carried out on a large scale.

The similar plain which lies to the eastward of the lake is already settled and cultivated to a large extent. The general surface would be quite level were it not for those tortuous and deep ravines which the rivers as well as the small brooks have worn out in all directions. A few outcrops of Laurentian rocks are also seen therein, outcrops which moreover, are always marked by slight elevations. This level tract resembles closely that occupied by the townships of Chicoutimi, Bagot and Laterrière, where the generally level surface is again only broken by the ravines made by the flowing waters, and its borders are occupied by ranges of Laurentian hills.

LAURENTIAN.—A.

The Laurentian in the area explored may be divided into two very distinct series. First, the hornblendic and micaceous gneisses, the granites, and the syenites, which are seen at Chicoutimi and Ste. Anne, along Lake Kénogami and on a portion of the shores of Lake St. John; and second, those extensive labradoritic masses which lie along the *Décharge* and on the eastern shore of Lake St. John.

I. *Gneissic Series*.—Gneisses predominate everywhere, whilst true granites and syenites are comparatively rare. At Ste. Anne, the rocks contain many hornblendic minerals. They are associated with a large number of quartzose and felspathic beds or bands which strike generally at right angles to the Saguenay River.

These bands probably indicate the original stratification, notwithstanding the fact that in certain cases they are strongly contorted and appear rather like veins or dykes. Yet, they are evidently contemporaneous with the associated rocks which hold them.

These indications of stratification are well exposed over the whole ridge which separates Ste. Anne from the *Terres rompues*.

A few indications of foldings can also be recognized. Moreover, similar beds can be traced to the mouth of the Saguenay, following essentially the same strike. A little above Shipshaw, the gneissic series is interrupted by a large band of labradorite. It reappears further, but sensibly changed as to its nature and appearance.

The felspar predominates, and the rocks, being more readily disintegrated, are more deeply attacked by the atmosphere. At la Dalle the rocky beds which form the shore of the Rivière des Aulnets, are rich in common garnets.

About five miles above the mouth of the Rivière des Aulnets on the Saguenay, the gneiss disappears completely and is replaced by nearly pure labradorite.

Unequal decomposition by atmospheric action since the glacial period on these Laurentian rocks is very marked; many of the rounded and

polished surfaces have become quite rugged. Layers of quartz and other minerals, rich in silica are left in relief, whilst those more easily decomposed have been removed to greater or lesser depths.

I must point out a very remarkable fact with regard to the erosion by the ice. As might be expected, the northern slopes of the rocky hills have been more effectively attacked than the southern. The crests of those which crop out from beneath the quaternary clays are worn and rounded on the northern slopes, whilst the opposite slope is still often abrupt and rugged, indicating that the course of the glacial current was from the north and north-west.

II. *Labradorite series*.—It is a difficult matter to locate precisely the first appearance of beds of labradorite along the Saguenay. Still it is only in the neighborhood of Shipshaw river that such beds can be said to acquire considerable development, on the north-eastern border of the *Décharge*. They are here intermingled with a certain number of beds of gneiss, such as we referred to above, and are consequently parallel to them. But at the Cran-serré, a little above the Duclos River, labradorite composes almost exclusively the rocks of the hills.

The colour of this labradorite is very dark brown with a tinge of blue in it. From exposure to the atmosphere, it crumbles into a greyish powdery material, and the rocky hills consequently assume a smoky hue which causes a singular contrast with the non-decomposed portions.

The rock is compact, with an eminent crystalline fracture and exhibits large crystals with faces marked by the characteristic striæ of the plagioclase feldspars.

In certain places these labradorite rocks have a cellular structure. This phenomenon arises from the decomposition of small patches of foreign minerals, originally imbedded in the labradorite and slowly dissolved by atmospheric agencies. This decomposition, commencing at the surface of these isolated patches, has extended by degrees to the centre, forming a number of chloritic leaflets, in clusters radiating around a central point. This peculiar leaf-like decomposition is due to an original concentric structure, developed by the action of frost and snow on the glacial surface. It is not rare to meet some *roches moutonnées* labradoritic in composition, the summit of which is covered with leaflets neatly separated. Their thickness varies from a few lines to a few inches. This exfoliation is much better marked on the surface of the labradorite rocks than on any other. These various disintegrating actions were doubtless at work previous to the glacial epoch as well as subsequently, and the labradorite rocks must have been decomposed to a greater depth than the granitic rocks at the time when ice invaded the country. Whence it follows

that these rocks have been more deeply eroded during the glacial epoch, and this would perhaps explain the fact that the labradorite hills of the Saguenay are, as a general rule, lower than the granitic or those of gneiss or syenite. At first sight it seems as if the surface of the country occupied by the labradorite had undergone a kind of a depression, whilst in reality this appearance may more likely be solely due to greater erosion.

To sum up my observations on these developments of labradorite, I shall state that these rocks occupy a pretty extensive area on the eastern shore of the Saguenay. They begin at the Shipshaw River, follow the Aulnêts as far as the sixth or seventh ranges of Bourget, without reaching lakes Chabot, Thomy and des Brochets, then are exposed on the northern shore of Lake St. John, from the *Décharge* to to the *Rivière au Cochon*.

This formation probably extends further north, perhaps reaching *Pérignonka River*. However, the extensive swamps between the *Lac des Brochets* and that river would render observations extremely difficult.

The island of Alma itself is composed solely of labradorite with a few beds of interstratified gneiss.

To the south shore of the outlet, similar labradorite masses are visible east of the Church of St. Dominique, and again continually on the right bank of the river as far as the lake. Finally they compose almost entirely the hills found between St. Gédéon and the *Petite Décharge*.

Amongst the most important minerals which this formation holds, titanite iron ore may be mentioned first.

The labradorite pebbles which are found in the neighborhood of Shipshaw often enclose this mineral, and it appears to occupy a position analogous to that which hornblende occupies in syenite, to such an extent that at first sight these rocks might be mistaken for ordinary syenitic fragments.

The mass which I was able to study most thoroughly is found on the first range of Bourget, at a short distance from Taché township. This mass is about two arpents wide and four or five long; but it is found again in different places on the same direction, at a considerable distance from the Saguenay. The mass in Bourget forms a regular hill, 150 feet high, composed almost exclusively of titanite iron. Felspathic veins with strange configuration are, however, found in the same. They remind me, remotely perhaps, of Prince Rupert's drops with this difference that they are much more irregular. Large crystals of labradorite are likewise often met with.

At first sight, the structure of these ferruginous masses is so disturbed that an igneous origin is suggested.

The action of the quaternary glacier was remarkably exemplified in the case of these minerals, large surfaces being found which have still preserved the original polishing. Others have become rugged, and cellular, by the decomposition of foreign substances originally mingled with the titanite iron.

The occurrence of ilmenite in several places which Sir W. Logan does not mention in the *Geology of Canada*, 1863, has also been noted. The principal ones are: At Jervais River, on the banks of Shipshaw, on the second range of Jonquière and on the first range of St. Gédéon.

A word now about the different veins which traverse the labradorite. At Trépannier Bay, on the island of Alma, there is a very remarkable vein of orthoclase pretty nearly pure and crystalline. It runs north-north-east from the bay and has a dip of about 70°. Analogous veins, two or three feet in thickness, are met with in various places on the islands of the *Petite Décharge*. Rather large dykes are also found composed of a kind of compact dolérite enclosing crystalline masses of hypersthene and ilmenite. These dykes can be seen again at the mouth of the *Grande Décharge* and on the shore in the vicinity of the *Petite Décharge* to the south. Their strike is nearly at right angles to that of the felspathic veins referred to above.

The Laurentian formations which I have examined hold several minerals which we will briefly cite here:

Mica is found abundantly. It is met with in large laminæ, capable of being utilized, at l'Anse à Caron, along the *Grande Décharge* and in the third range of Jonquière. From this latter place we had sheets of a mica, black in colour, about two feet square.

Sulphide of antimony was found in a very narrow vein crossing the Saguenay at the height of the broken lands (*Terres Rompues*) close to a remarkable development of titanite iron. On the eighth lot of the thirteenth range of Laterrière occurs a quartzo-felspathic vein running from north-west to south-east, enclosed in gneissoid rock. It contains a very small quantity of graphite disseminated throughout in small masses.

Another quartzose vein is found three miles from the Portage des Roches on the right bank of the Chicoutimi River. Its thickness is from eight to ten feet and direction north to south. It is rich in iron pyrites. Gold was thought to have been present, but the analysis has shown that the pyrite was not auriferous.

In the township of Jonquière, on the north range of the road leading to Kaskouia there is a curious agglomeration of precious minerals, specially garnets and emerald. The garnets are rarely transparent, save those surrounded by masses of mica, but then they are unfortunately very small. The emeralds belong to that variety called

“aqua-marine.” Crystals have been found reaching a diameter of three inches and more and a length of from twelve to fifteen inches.

The crystalline limestones which are elsewhere characteristic of the Laurentian were not observed anywhere. The only calcareous rocks met with are a few narrow veins traversing the Laurentian hills in various places. Such are, amongst others, the veins of Shipshaw, near the Grande Décharge.

However, I must especially mention a much more considerable mass of lime-rock examined on the second lot of the first range of Metabetchouan, quite close to the so-called Quebec road. On the side of a hill some one hundred feet in height and running north and south a mass of white limestone coarsely crystalline can be observed which is composed of rhombohedral crystals. This limestone rock may be seen more than fifty feet long and about twenty feet thick. It is surrounded by gneiss which is also found in all the adjoining hills. Unfortunately the mineral and vegetable detritus which cover the country render the examination extremely difficult, to such an extent that it is almost impossible to define the boundaries of the limestone in a precise manner. Whether it is a vein or a remnant of a large mass of crystalline Laurentian limestone could not be affirmed with certainty.

CAMBRO-SILURIAN.—D.

The examination of the Cambro-silurian formations was one of the principal parts of my programme, accordingly I have paid particular attention to the same.

In the Geology of Canada, 1863, Sir W. Logan mentions solely the limestones which occur on the island at the entrance to the *Petite Décharge* and those which border the southern shore of Lake St. John from Metabetchouan to Blue Point. I believe that I have discovered the boundaries of another large Cambro-silurian basin to the north-east of the Saguenay, not reckoning a goodly number of smaller areas, which, although isolated, can however be grouped so as to form minor, but perfectly characterized basins. As the first-mentioned and largest is for the most part in Ste. Anne parish, I shall call it the Ste. Anne Basin.

The strata which compose it are all limestone and referable to the Trenton Group. The following is a list of the localities where I have ascertained their occurrence with the leading characteristics which they offer in these different places:—

First, they are found on the third range of Tremblay, about 40 arpents from the Saguenay, and about 270 feet above the river. There they rest directly on the gneiss, and their thickness is so slight, at least on the border of the formation, that the undulations of the gneiss are

brought to light through their edge. The absolute horizontality of the Trenton beds prevails over the whole of the Ste. Anne basin. The road crosses this calcareous series, almost at right angles to the strike of the strata, which is south-west. It here forms a hill about 40 feet high. To the south-west it abuts against Laurentian masses. To the north-east it dips below the deposits of quaternary clays. It has in that locality a width of about 30 *arpents*. The quaternary clays which begin here, form an extensive plain stretching to the limits of the townships of Tremblay and Simard. The general surface is quite regular, except in those places where brooks and rivers run, whose beds are always worn deep. The soil is very fertile, and already a fair portion of it is being cultivated.

Towards the boundaries of the township mentioned above, the surface rises sensibly, and between Lakes Caribou and Charles another limestone band is seen to crop out quite like the limestones of the third range of Tremblay. The gneiss hills begin again beyond and continue as far as the Valin Mountains which separate the waters of Saguenay from those of the Betsiamits River. This band of limestone is somewhat thicker than the one already described. It is also longer, for it is found again between Lake Tortu and River Shipshaw, a very good natural section of it being there exposed. The Shipshaw River itself runs more than a mile upon these limestone beds, the Ours River, which flows about a league west of the Shipshaw, does the same.

On the eastern side, at the boundaries of Tremblay township, the Valin River has likewise worn its bed in the limestones, and that to a considerable extent.

From all these observations it can be affirmed that to the north of Tremblay and Simard townships, there exists a great band of Trenton limestone running almost parallel with the boundaries of those townships.

The limestone band first referred to also extends in a direction from east to west, being found again at Riviere aux Vases and Caribou River. In both places the beds are overlaid by very extensive deposits of clay, but these are cut through by both rivers down to the limestone.

Apparently the two bands of limestone are only parts of the rim of a large basin, its central portion being covered and concealed by the alluvial deposits referred to; as on the eighth range of Simard, between the 11th and 21st lot, the limestone is only a few feet below the surface over a breadth of about twenty *arpents*. This is also the case in the sixth range of the same township, where the soil is literally covered with pebbles of limestone. In this last mentioned locality an abundant sulphurous spring occurs.

To sum up, I have ascertained the presence of limestone over an area about ten miles broad and seventeen miles long. In the whole of this area there is not a single outcrop of the gneissic series. It is an extensive wooded or cultivated plain. This Cambro-silurian basin is, as stated, limited to the north and south by the limestone bands just described, but it is not so to the east and west. Time did not allow me to examine the eastern boundary. As to the limits of the basin to the north-west I believe it to be very difficult to determine, seeing that from the River Ours to Péribonka and to Lake Tshistagama, the surface of the country is only a vast plain often covered with swamps and where no rock outcrops have been seen. This remark, however, applies only to that portion which lies beyond the surveyed townships, for the contrary is the case in these latter. In fact the Aulnets River, which crosses Bourget township, in no place flows over limestone beds. Lakes Chabot, Thomy, and des Brochets have gneiss or labradorite shores, the same is the case with the Mistouc River. The limestone basin of Ste. Anne is, therefore, clearly limited on that side.

There is no doubt that these limestone formations were originally more extensive, and that they were reduced to their present dimensions by glacial erosion, which has left too extensive traces on the granite hills of the Saguenay not to have affected considerably the comparatively soft surfaces of the adjacent palaeozoic rocks.

The limestone beds are everywhere crossed by numerous joints belonging to two systems nearly at right angles. The lower beds, those which are in close contact with the granite, are compact, dark in colour, with a light tinge of blue. Fossil remains are abundant. They are found crowded together, especially in certain beds. However, it is difficult to find perfect specimens. They are naught but fragments accumulated in such a way as to make identification almost impossible.

Besides the fossils, there are seen in the mass of the rock small crystalline grains, such as are found in the Bird's Eye formation.

In the upper beds of the same basin, the fossils are more abundant. A few layers appear to be almost exclusively composed of crinoid stems. Tombstones obtained from these beds present specimens of pretty palaeozoic algae. Let us also add that these beds are crystalline and resemble pretty closely the limestones of Deschambault.

Petroleum is not rare throughout this whole area of Cambro-Silurian rocks. Sometimes it exudes spontaneously from the cavities of the rock, and when the rock is heated it gives forth a very marked bituminous odour. All the limestones of the Saguenay are also bituminous, which establishes clearly their relation to the Trenton group.

To complete the study of Ste. Anne basin, it would be necessary to find out the eastern and western limits, and also ascertain besides other facts, whether there are not between Valin Mountains and Betsiamits River deposits which belong to the same horizon. The guides certify that rounded pebbles of limestone are found throughout that whole region.

Lake St. John Basin.—In the Geology of Canada, 1863, Sir W. Logan states that the limestone formations must probably nearly cover the bottom of Lake St. John, though it is seen only in two places. As regards the boundaries of these two limestone areas, as laid down by Sir William, I shall point out* that the first one does not begin at the mouth of the Metabetchouan, but about a mile and a half farther west. The formation attains almost immediately a thickness of about one hundred feet, always in horizontal beds except near the lake, where they dip towards it. It is, moreover, singular that the beds of this whole limestone area, which are near the lake, always dip towards it.

At the point where these limestones first appear, black bituminous beds of Utica slate are found resting unconformably against the limestone; a phenomenon probably due to a fault. These beds hold such a quantity of bitumen as to have caused the farmers to mistake them for coal, finding that they burnt with a flame.

At Ouiatchouan River, the Utica shales rest conformably on the limestones, being directly superimposed. Here they are but slightly developed, and disappear beneath huge masses of clay. At Ouiatchouanish River the limestones rest immediately upon the granite. Fifteen arpents west of Point Blue, the Utica argillites reappear, resting conformably on the limestones. They dip considerably towards the lake.

The Cambro-Silurian band along the north-western shores of Lake St. John is relatively narrow. It scarcely extends beyond the second range of the Metabetchouan and Chambord and the first range of Roberval. Farther south the granitoid Laurentian hills begin. These limits are only approximate, seeing that I had not an opportunity of studying them in detail. It would be very interesting to ascertain exactly that line of demarcation, also to make sure whether the limestone band around Pointe Bleue is continuous over the vast basin where the Ashouapmouchouan and its various tributaries flow. There is every reason to believe that another paleozoic basin, equally developed, may be found there.

The limestone island referred to by Sir William Logan, which is situated at the mouth of the *Petite Décharge* is very large. When the water is low its exposed length is from three to four miles and its breadth two. The limestone may even be traced beneath the waters

at a good distance from the island. This island is itself but little elevated, and when the water is high, is completely submerged except the tops of the trees which cover its surface; the beds, always horizontal, abound in fossils: corals, brachiopods, gasteropods, cephalopods, &c.

It is natural to suppose that this limestone island is one of the sources of the pebbles of limestone which are found quite often on the shores of the outlet of Lake St. John, and also in places apparently very remote, from limestone formations. In this light I have noticed such pebbles at the Grand Remoux, at Jervais Rapids and in various places along the *Petite Décharge*.

They are torn up by the ice and transported here and there during high waters.

I have further found limestone beds in many other localities at the eastern extremity of Lake St. John, to such an extent that formerly this formation must have covered the whole of that portion of the country in which are now the parishes of St. Jérôme, Hébertville, Grammont and Alma, except perhaps a few Laurentian islets. It was subsequently removed by successive denuding agencies. The limestone pebbles, however, still lie around to such an extent sometimes as to allow the erection of lime-kilns. Among such places may be mentioned, the 30th lot of the eighth range of Signay, the 7th and 8th lots of the first range of Alma, different lots situated at a short distance to the north-east of Grammont church, and near St. Jérôme church, moreover, there are others where the limestones are still *in situ*.*

On the Island of Alma, twenty arpents to the east of Trepannier Bay, there is an outcrop of limestone resting directly upon the Laurentian rock. As the exception, these beds are highly inclined toward the north-east.

On the other side of Alma Island on the right bank of the *Grande Décharge* we find a similar limestone formation. The same is the case on the 25th lot of the eighth range of Signay, where horizontal limestone beds are, as it were, imbedded in a nest of granite. At that point where the road of the third range of Caron crosses the river Koushpa-ganish, it flows over limestone beds slightly inclined to the north, and

* These Trenton limestone outliers are economically important as a source of lime, and they are also geologically of great interest as indicating the area once covered by the Cambro-silurian ocean. The discovery of more such outliers, in the great unexplored Laurentian region between Hudson's Bay and the St. Lawrence, may yet prove that the Laurentian Continental nucleus was wholly, or in great part submerged, perhaps more than once in early palæozoic ages. Such repeated oscillations and the great denudation resulting from these may easily have destroyed all traces of formations once superincumbent to the Laurentian. It is therefore in a modified sense only that the present extent of these palæozoic outliers can be ascribed to glacial erosion which was one of the latest only of the denuding agencies which have taken part in producing the existing physical outlines.—A. R. C. S.

covered above with more than 100 feet of clay. Further to the west limestones again crop out, on the 7th and 8th lots of the fifth range of Metabetchouan. The dip is 30° to the north, and their visible thickness about 40 feet. The beds are thick and would afford good building-stone. Their extent is from twelve to fifteen arpents in length and five or six in breadth. Travelling towards Hebertville similar beds present themselves near Lac à la Croix, in a small Laurentian depression which preserved them from glacial erosion.

A noteworthy fact is that in all the points of contact which I have been able to observe between the Laurentian and the Trenton, the latter rests directly upon the former, no traces of the Potsdam Calcareous or Chazy being seen. Moreover, whilst the Utica formation is present only in a few instances, still *debris* from it are found on the shores of the lake and very often inland to such an extent that we are forced to conclude that the whole area of the Trenton was formerly covered with this formation. I have pointed out in the course of these remarks the fact that the limestones are often enough found in nests or outliers amongst the granites. Therefore, these depressions and hills of Laurentian age must necessarily have existed at the bottom of the palæozoic ocean where the limestone beds were being deposited. Consequently, even previous to Cambro-silurian times, erosion had already strongly attacked the gneisses, however hard they were, and to a considerable extent modified their surface features.

There remains to be pointed out another limestone deposit on the 3rd and 4th lots of the third range of Bagot, near the fourth range. The limestone is visible upon a surface of three or four arpents. Elsewhere it is completely covered with the quaternary clay. Here again, as throughout the whole Saguenay region, the limestone rests distinctly and immediately upon the granite. Fossils are not rare in this limestone, and cavities filled with petroleum are also found therein. In the large plain which includes the parishes of Chicoutimi, Grand Brûlé, St. Alphonse and St. Alexis, I have not found any limestone except where mentioned above. However, it is quite probable that it should be met with beneath the clay in many localities. In fact, these parishes form a large basin similar to that of Ste. Anne. The Laurentian outcrops are few and but slightly elevated. The general surface of the country is level enough except the ravines worn out by the rivers and brooks. Further, but a few years ago, limestone beds were blasted near the spot called "*les battures*," on the right bank of the Saguenay, about on the same level with the limestones of Bagot. It is then not impossible that we have there again another palæozoic basin in which erosion first, and the accumulation or heaping up of the detritus of glaciers next, have destroyed or concealed the greater portion of these deposits.

To recapitulate, I must say that besides the Cambro-Silurian formations pointed out by Sir William Logan, the region of the Saguenay comprises others situated in the Ste. Anne parish, various small outcrops east of Lake St. John, and less extensive deposits in Grande Baie plain, to such an extent that the palæozoic ocean must have been there co-extensive with that of the quaternary age.

POST-TERTIARY.—M.

The Post-tertiary deposits of the Saguenay are clearly divisible into two groups just as Dr. Dawson's study published in the *Geology of Canada*, 1863, indicates. The lower group comprises the boulder clay, overlaid by a more or less thick deposit of stratified clay. The upper group consists almost exclusively in beds of sand holding at times pebbles of goodly size evenly rounded. This sandy group is never very thick. The brooks and rivers have worn out their beds in these easily moveable formations into ravines of great depth with steep sides.

The palæozoic basin of Ste. Anne is covered with a thick bed of clay. The sandy deposits are only met with in the western portion near Aux Vases River (Mud River.) It is a curious fact that we frequently find the sandy surfaces of the terraces entirely or in part occupied by swamps. Such is the case, amongst others, near the Aux Vases River, in the neighborhood of Lake des Brochets and between Chicoutimi and the Grand Brûlé.

Little by little the water of the swamp permeates through the whole sandy mass and reaches the surface of the clay. It then follows the impermeable surface of the clay in the direction of the greatest slope and comes forth in the shape of abundant springs in the worn out ravines. The springs always come from the line of junction of the sand with the clay.

At this exit a quite remarkable chemical action takes place at times. The ferruginous material of the clay and sand is decomposed. A more or less abundant formation of yellow ochre results, and is carried away by the spring-waters. The numerous bog-plants which grow abundantly in these places undoubtedly have a great deal to do with these chemical actions.

This formation of *limonite* is particularly noticeable in the upper portion of Mistouc River, along the Rivière des Aulnets and also along Bear River. But the most remarkable place in this respect is at the source of one of the tributaries of the Aux Vases River, where there is a small vale surrounded on three sides by sandy swamps. Water rises in abundant springs, escaping in several small brooks, the union of which constitutes one of the principal tributaries of the Aux Vases

River. The ochre formed on the brow of the hill is carried away by the water and is deposited in the lower portion. There is then a deposit of oxide of iron the thickness of which varies from three to twelve feet in an area of more than twelve arpents in length and five or six in breadth. The surface portions are of a rusty yellow colour, but this colour disappears at a certain depth and assumes a greenish-brown hue. This ochre holds but little silica and could be obtained with great facility.

From the Terres Rompues going up the Saguenay, the clay deposits have no longer that uniform evenness found below. However, they remain stratified throughout, but have been ploughed and denuded by the waters to such an extent that their primitive surface is entirely gone. They are only argillaceous or arenaceous hillocks inserted between Laurentian hills. At Gervais Rapids the general surface becomes regular and remains so to Lake St. John. However, the immediate neighbourhood of the *Décharge* and Lake Kenogami is always more disturbed than the remote districts, which proves that the waters extended over the country in large volume when the lake basin was narrowing in at the close of the Champlain epoch.

When all the terraces of Lake St. John are examined together, a fact immediately strikes the observer. It is that these terraces are much more elevated on the south-eastern shore of the lake than in any other place. At Hébertville, for instance, they are nearly 200 feet above the level of the lake. From this, as a central point, their level lowers usually almost imperceptibly as far as St. Prime on one side and Grammont on the other.

This fact appears to me to be capable of interpretation in two ways. It may be that the elevation which marked the close of the glacial inundation was felt to a greater extent in that part of the shore than elsewhere. Or else, the phenomena of erosion may have been felt more, near the *Décharge* and at the opposite extremity, near the Ashuapmouchouan, so as to remove the greater portion of the areno-argillaceous terraces. The former explanation seems to me to be preferable, inasmuch as there is not seen at the surface of the terraces of the Grammont, the *Décharge* and Rivière à la Pipe that deep ravine-cutting which ought to have taken place there as they did lower down, along the *Décharge*, where the waters have acted powerfully. The north-eastern shore of the lake between the *Décharge* and Péribonka should, however, be examined in detail before adopting this conclusion as final.

The rivers which flow into Lake St. John from the north carry with them a great quantity of sand, produced by the rapid decomposition of the hills which border their upper portions. These sands are

first spread out in the lake and tend to fill it continually. They are very different from the quaternary sands proper, seeing that they contain a considerable quantity of garnets and of magnetite.

The sandy masses are still accumulating into narrow ridges upon the shore of Cochon River as far as St. Jerome. The wind which plays the principal part in the formation of these, acts as a sifter. The garnets and magnetite, which are very heavy, remain near the water, whilst the lighter quartzose grains are driven into the interior, toward the summit of those ridges or *dunes*. These reach a height of 190 feet in some instances. Beyond these arid hills the soil is argillaceous and fertile, being part of the ordinary quaternary terraces.

J. C. K. LAFLAMME.

